Faculty of Resources Science and Technology

COMMUNITY STRUCTURE OF THE MACROBENTHOS IN TANJUNG BAJONG, SEBUYAU, SARAWAK

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DECLARATION

I hereby declare no portion of the work referred to in dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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LIST OF ABBREVIATIONS

Abbreviation		Description
%	:	Percentage
DO	:	Dissolved Oxygen
SPSS	:	Statistical Package for Social Science
TOM	:	Total Organic Matter
NOM	:	Natural Organic Matter
OC	:	Organic carbon
GPS	:	Global Positioning System
mg/L	:	Milligram per Litre
NTU	:	Nephelometric Turbidity Units
PSU	:	Practical Salinity Units
TDS	:	Total Dissolved Solids
Na^{+}	:	Sodium ion
Cl^{-}	:	Chloride ion
$Ind./m^{2}$	:	Individual per one meter square
Mg/m^{3}	:	Milligram per cube
g	:	Gram
m	:	Meter
cm	:	Centimetre

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Community Structure of the Macrobenthos in Tanjung Bajong, Sebuyau, Sarawak

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ABSTRACT

Studies were conducted in the field and laboratory to determine the community structure of macrobenthos species in the subtidal area of Tanjung Bajong, Sebuyau, Sarawak. Sediments were collected in six stations using Van Veen Grab sampler and simple flow through corer sampler for sediment collected. Four phyla of macrobenthos (Mollusca, Annelida, Arthropoda and Echinodermata) were recorded in which include four species of polychaetes, two species of malacostraca crustacean, one species of bivalve and one species of echinoderm. The species numbers of polychaetes were found to be dominant at all stations. The species diversity of macrobenthos ranged from 1.58 to 2.32. Macrobenthos found in Tanjung Bajong are typical of animals found in tropical waters.

Key words: macrobenthos, subtidal area, Shannon-Weaver diversity, Pielou's evenness

ABSTRAK

Kajian ini telah dijalankan di lapangan dan makmal untuk menentukan struktur komuniti bagi spesies makrobentos di kawasan Tanjung Bajong, Sebuyau, Sarawak. Persampelan sedimen telah dilakukan di enam stesen dengan menggunakan pengorek Van Veen dan korer aliran telus yang mudah. Empat phyla makrobentos (Moluska, Annelida, Arthropoda dan Echinodermata) telah direkodkan. Ini termasuklah empat spesies Polychaeta, dua spesies krustasea malacostraca, satu spesies Bivalvia dan satu spesies Echinodermata. Jumlah spesies polychaeta adalah dominan di semua stesen. Kepelbagaian makrobentos adalah dari 1.58 hingga 2.32. Organisma makrobentos yang ditemui di Tanjung Bajong adalah haiwan tipikal yang wujud di perairan tropika.

Kata kunci: makrobentos, kawasan pasang surut, kepelbagaian shannon-weaver, kesamarataan spesies

2.0 Introduction

A community is any assemblage of population of living organisms in a prescribed area or habitat (Krebs, 1978). There are five traditional characteristics of communities; the species diversity, growth form and structure, dominance, relative abundance and tropic structure (Krebs, 1978). Alternatively, a community can also be described by means of a species list (species composition) or by stating the total number of species (species richness) (Moore, 1983). The total number of individuals of each species per unit area (density) can be listed and either weight (biomass) or the amount of tissue each species produces in a unit time (production) can be determined (Moore, 1983). According to Cox (1990) a group of species that characteristically occur together in a certain habitat represents a community.

Macrobenthos can be defined as organism that live at the bottom of water column and cannot see by naked eyes. The range of size is between 0.5mm (500µm) to 1mm (1000µm). The distribution is depending on the environmental factor and also internal factor. Every species of macrobenthos have their own specialised to adapt in the area. The example of macrobenthos organisms are lamellibranch, tanaidacea, crabs (ocypodid and grapsid), worms, gastropods, crustaceans, sponges and polychaete. George *et al.* (2009) noted that macrobenthos play an important role in marine ecosystem which includes mineralization, mixing of sediments and flux of oxygen into sediment, cycling of organic matter and assessing the quality of inland water (Esenowo, 2010).

The distribution of macrobenthos are determined by a number of factors such as physical nature of the substratum, depth, nutritive content, degree of stability and oxygen content of the water body. The abundance of macrobenthos will be carried out by determining the species diversity, species richness and species distributions. Diversity indices will be compared based on their diversity in particular station.

Earlier researcher studied the natural history of the benthos and autecological relationship (Moore *et al*, 1970). The term "community" is used here to describe benthos in terms of related species distribution, grouping together organisms that frequently occur together under similar environmental conditions and a part of each other biological environment. These studies also include an investigation of relationships of the benthos to salinity, dissolved oxygen, and sediment composition through sediment analysis. The importance of salinity on those organisms is well documented, and this is likely the single most important factor affecting the distribution of the benthos.

According to MacIntyre, 1968 and Coull, 1970, dissolved oxygen levels can also exert tremendous effect on the distribution and occurrence of benthic organisms, especially in those marine environments where stratification of the water column results in anoxic conditions in the water overlying the bottom (Tenore, 1970). Sanders (1958, 1960) noted that sediment composition has also been shown to influence the distribution of the benthos (Tenore, 1970).

Sediment analysis will proved that the nature of sediment is determined by the complex interaction of a huge number of factors which are falling down into four categories:

1. Factors determining source and supply for sedimentary material
2. Factors determining transportation
3. Factors determining deposition
4. Post-depositional changes of mainly biogenic origin (e.g. biodeposition and bioturbation).

The study of macrobenthos species in Tanjung Bajong area is currently limited. Beside, it is important to investigate the relationship of sediment size with macrobenthos abundance. The objectives of this study are to determine the community structure of macrobenthos in Tanjung Bajong, to update the data of species diversity and species richness of macrobenthos in the area and to study the relationship of sediment and species abundance at the particular station.

3.0 Literature review

3.1 Macrobenthos

The term "community" is used to explain macrobenthos in terms of related species distribution, grouping together organisms that frequently occur together under similar environmental conditions and are a part of each others biological environment. The community of benthic are essential to marine ecosystem and form crucial diet source for most marine organisms especially fish. Research of this biota is essential as it could be an indicator to whole aquatic productivity (Sakri *et al.*, 2006). The community of soft-bottom is of the minor research biological element of the tropical zone. They have been view comparatively unimportant since they seem barren, unpolluted and unproductive (Onate-Pacalioga, 1994 as cited by Sakri *et al.*, 2006). The abundance of benthic fauna is a biological parametric quantity that may point the whole aquatic productivity of the bottom sediments. They are also the main source of diet for both migratory and permanent fauna as well as higher predators in the food chain (Sakri *et al.*, 2006). In this study, the sedimentary factors considered were the gross differences between sand and mud substrates, including particle size differences within these two broad substrate types, and the organic matter concentrations in the sediment.

3.2 Community structure of macrobenthos in Malaysia

The macrobenthos's importance and role in the aquatic ecosystem especially marine ecosystem has long been identified and discussed. These macrobenthos, mostly comprising the marine invertebrates, are extremely diverse biologically and always being found on the continental shelf. They build a major diet for the bottom feeders like demersal fish (Hamid, 1997). Overall surveys on the macrobenthic model found within the water of Malaysia and Thailand are rarely conducted due to the several logistic matter and high costs demand. Some previous research always mentioning, although these were supervised on a much smaller scale, are those by Chua *et al.* (1980), Othman *et al.* (1989), and Lotfi *et al.* (1994) in the waters of Malaysia, and Aryuthaka *et al*. (1991) and Sanguansin (1986) in the Gulf of Thailand (Hamid, 1997). In Malaysia, macrobenthos invertebrate are not been practised to study the river pollution because the Department of Environment (DOE 2001) has not included this methodology for the river pollution research (Yap *et al.*, 2003). The hydrology of the river along the length of the watershed could be changed but the more significant factor in changing the distribution of benthic macroinvertebrates is the anthropogenic inputs. This is well supported by the human activities found in the downstream of the river (Yap *et al.*, 2003).

3.3 Community structure of macrobenthos in temperate region

Temperate region is the region which the climate undergoes seasonal change in temperature and moisture. Temperate regions of the earth lie primarily between 30 and 60 degrees latitude in both hemispheres. The geographical areas in which mean annual temperatures are between + 30°F and + 70°F as identified by isothermal lines. There is some country that situated at temperate region which are Peru, South Africa, some of Australia lie in this zone. At lower reaches of temperate, invertebrate was dominated (Branch and Grindley 1979 as cited by Christoff J, 2010). The importance of deposit feeding polychaetes, the magnitude of population fluctuations, the types of niches being exploited, and the existence of seasonal patterns, makes this community similar to certain temperate zone counterparts (JA. Vargas, 1987).

Macrobenthic communities in temperate regions are subjected to a large year-to-year variability of the community structure (Turner *et al*., 1995 as cited by G. Van Hoey *et al*., 2004). Temporal variability should thus be considered as being subordinate to spatial variation and the existence of six relatively stable macrobenthic communities at the BCS can be confirmed (G. Van Hoey et al., 2004). The number of ecological surveys on meiofauna and macrofauna in the temperate has been higher when compared to tropical regions (Armetos *et al*., 2007). A warm temperate estuary, the macrozoobenthos of subtropical estuaries is dominated by crustaceans, which in turn are largely dominated by brachyuran taxa.

3.4 Community structure of macrobenthos in tropical region

Tropical region is where include all parts of the world between 23.5° north and 23.5° south latitude. These are the limits beyond which the sun never appears directly overhead at any time of the year. However, because of terrain, winds, and ocean currents, tropical climatic types may stray outside these geographical limits, or may not quite reach them. In the Western Hemisphere, tropical countries include Mexico, all of Central America, all of the Caribbean islands from just south of Nassau in the Bahamas, and the top half of South America, including Colombia, Ecuador, Peru, Bolivia, Colombia, Venezuela, Guyana, Suriname, French Guiana, as well as the northern portions of Chile, Argentina, Paraguay, and Brazil. A lot of studies being done on species richness of shallow marine soft sediments, especially on benthic communities that are widely ides for monitoring the condition of coastal ecosystem. However, the data are probably representative of intertidal and coastal areas in temperate regions, quantitative data from sub-tropical and tropical areas are still lacking (C.R.S. Barrio Froján *et al*., 2006). As in most ecological data sets, the majority of polychaete species were represented by a small number of individuals and the majority of individuals belonged to a few abundant species. According to Pearson and Rosenberg (1978), unstressed sites show many rare and few common species along a stressor gradient. Conversely, stressed sites have fewer rare species and are heavily dominated by a few abundant species. Such a preponderance of rare species found by this study does suggest a relatively unstressed environment. The need for adequate description of tropical marine macrofaunal communities is a theme which has been raised repeatedly and strongly by a number of researchers (Froján *et al*., 2006).

3.5 Community structure of macrobenthos in Sarawak

There is a study being done in Sarawak by comparing with Brunei and Sabah. This study was conducted two times which are during pre and post North-East monsoon. According to the report done, the macrobenthic abundance in Sarawak was more abundance than macrobenthic in Brunei and Sabah area both in the pre and post NE monsoon periods (Montira, 1997). According to the earlier research the species of mollusc recorded in Sematan are similar to the species recorded from other rivers and estuaries in Peninsular Malaysia (Berry 1972, Macnae 1968, Ng and Sivasothi 1999, Sasekumar 1974 as cited by Ashton *et al.,* 2003), Thailand (Brandt 1974, Frith *et al.,* 1976 as cited by Ashton *et al.*, 2003) and Indonesia. The most abundance macrobenthos in Sarawak is polychaete.

3.6 Physico-chemical parameters

Macrobenthos were found in all rivers and the have special roles in organic matter dynamics and trophic energy transfer in the river ecosystem (Harshey and Lamberti 1988 as cited by Yap *et al*., 2006). The habitats in subtidal area are subjected to extreme physical and biological gradients related to the frequency and duration of tidal inundation (Kneib 1984 as cited by Christoff, 2010). The variables such as desiccation, temperature and exposure are important regulating differences in community structure between tidal influence sites and between sites of varying elevation (Bursey and Wooldrige 2002, 2003 as cited by Christoff, 2010). Within the major processes involved, metal exchanges at the "water column/sediment" go through fundamental role along with the storage and release capacities (Yap et al, 2010). They are extremely influenced by the physico-chemical properties of the biotopes but also by biotic factors (Ciutat *et al.,* 2005 as cited by Yap *et al.,* 2010).

According to multivariate analysis, Collado and Schmelz (2001) found the distribution design of oligochaete species present are significantly correlated with depth, season and substrate. Depth is main factor when the whole water body is considered (Yap *et al.,* 2010). Since significant changes in water quality parameters directly influence the community structure of macrobenthic invertebrates (Victor and Onomivbori, 1996), surface water temperature probably had no effect on the distribution of benthos in this study. The high variability in the other water quality parameters may be due to the impact of extrinsic factors (e.g. rainfall and surface run-off) and sub intrinsic factors (e.g. sedimentary or depositional nature) which prevailed during the rainy and dry seasons respectively.

3.7 Sediment analysis

Sediment analysis is important to determine the relationship between distribution of macrobenthos and environmental factor. Macrobenthic distribution is highly correlated with the type sediment, which is related to a huge area of environmental conditions, such as current velocity and sediment organic content (Gray, 1974; Creutzberg *et al.*, 1984; Buchanan, 1984; Snelgrove and Butman, 1994 as cited by *Gert et al.*, 2004). The interrelated between the groups of soft-bottom animals and certain sediment types and depth zones was first explained by Perterson (1914). Jones (1950) justify forward an alternative groupings of species based on sediment and depth properties, followed by several authors ((e.g. Thorson, 1957; Kingston and Rachor, 1982; Duineveld *et al.*, 1991; Heip and Craeymeersch, 1995; Degraer *et al.*, 1999a) (Gert *et al.*, 2004).

The most common sediment analyses are total organic matter and particle size analysis. Total organic matter is a rough estimate obtained by measuring the loss of weight on ignition at 500°C of dried sediment sample from which the carbonates have been previously removed by acid treatment (Holme and McIntyre, 1984). For particle size analysis, an electric beverage mixer is an ideal instrument for the mixing and dispersal of sediment sample. The Wentworth grade classification and Wentworth scale was used for further analysis of collected data.

4.0 Materials and methods

4.1 Study area

Field trip was carried out from 15 Disember to 18 Disember 2012 at Tanjung Bajong, Sebuyau, Sarawak. Tanjung Bajong is situated in between two main rivers namely Batang Lupar and Batang Sadong. The mangrove trees grow along the shoreline. The effluence sources of turbid water possibly from quarry area. During low tide, the mudflats extend almost one kilometer towards the sea. The sediment is muddy. The sampling was carried out at six stations (Fig.1). The distance between each station was about two kilometer. The coordinate of the six stations were shown in Table 1.

Table 1: The location of the sampling stations

Station	Coordinate	Weather
1	N 01º 34. 989' E 110º 48. 134'	Clear sky
2	N 01º 34.900' E 110º 48. 457'	Clear sky
3	N 01º 34. 685' E 110º 48. 861'	Cloudy
4	N 01º 34. 552' E 110º 49. 165'	Cloudy
5	N 01º 33. 427' E 110º 50. 693'	Clear sky
6	N 01º 32. 308' E 110º 52. 333'	Clear sky

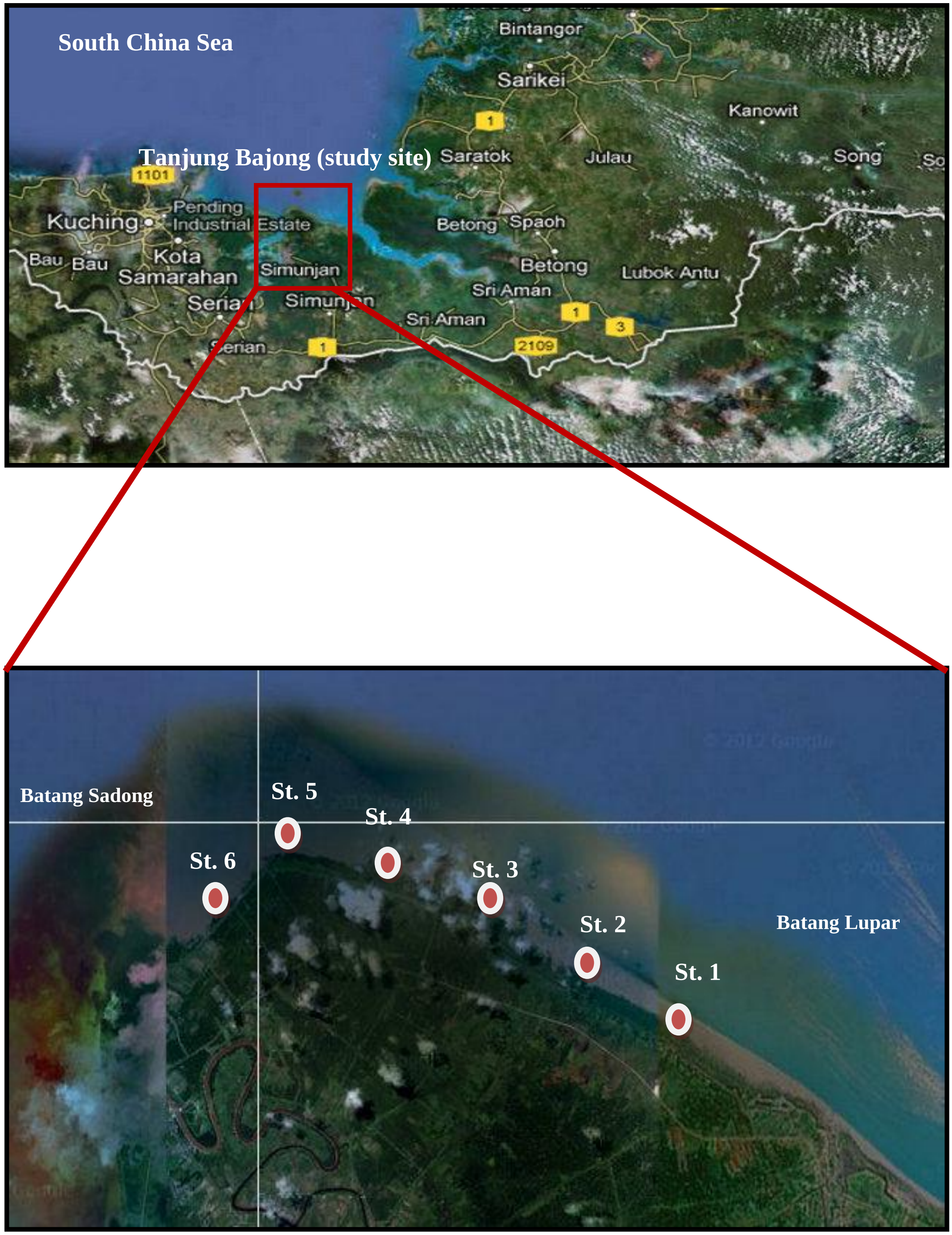

Figure. 1: The location of sampling stations along the Tanjung Bajong coastal area

4.2 Sampling

4.2.1 Physico-chemical parameters of the water

The location of sampling stations was fixed using the Global Positioning System (GPS) (Model- Map 60 CSX). The water depth was determining using depth finder. Physico-chemical parameters of the water such as temperature, pH, dissolved oxygen, turbidity, salinity and conductivity were measured in situ using multiprobes meter, model Eutech Instrument PCD 650.

4.2.2 Biological sampling

Six sampling stations were established along the Tanjong Melaban coastal area which (Fig. 1). The sampling were conducted during sunny day. At each sampling station, three replicates samples of macrobenthos were collected using 0.1 m^2 Van Veen Grab sampler (model). The sediment collected was washed and sieved by using 500 µm sieve and the retained materials on the sieve was washed and put into a labeled plastic bag. The sample was preserved in 10% formalin. The samples were stained with Rose Bengal and samples brought back to the laboratory for further analysis.

4.3 Laboratory analysis

4.3.1 Macrobenthos Identification

All samples of macrobenthos from labeled plastic bag were transferred into specimen bottle according to their station. Formalin solution was changed with 70% ethanol for long term preservation. For further analysis of animals at each station, the sample was poured into the petri dish and enumerated using stereo microscope and compound microscope up to the class lowest taxa level.

4.3.2 Total Organic Matter

The sediment collected was weight and transferred into the petri dish. The empty petri dish was weight before the sediment was put into it. The weight of petri dish and sediment were then recorded. All sediment samples were dried in an oven with temperature of 120ᵒC and let's overnight. After 24 hours, the sample was taken out from an oven and weight again by using electronic balance and the reading were recorded for data analysis.

4.3.3 Particle size analysis

The sediment was placed in a petri dish in order to be weighted. The weight of a empty petri dish was recorded first before the weight of sediment and dish. All samples were analyses according to their station and allowed them to dry overnight at 60ᵒC in oven. The particle size analysis was followed those methods proposed by Buchanan 1984.

4.3.3.1 Pretreatment

The dried samples were weighted again and transferred all of them into separate beaker and labeled according to their stations with. 100ml of 6% of hydrogen peroxide were added in each beaker and the samples were left overnight. The used of hydrogen peroxide was to break up any clumps in the material. The contents were washed onto a filter paper (Whatman 50) in a Buchner funnel. It was washed under gentle suction with distilled water. 300ml of water was added together with 10ml of sodium hexametaphosphate ($NaPO_3$) and stirred for 15 minutes in order to disperse the sand sample in $NaPO_{3.}$ This was done in order to separate the fine and clay particle. The soak sediment was left overnight.

4.3.3.2 Initial splitting of silt-clay fraction

The sediment was stirred again for 15 minutes and transferred to a 63µm sieve placed in a flat bottomed white basin. 300-400ml of distilled water was added sufficiently to flood the sieve surface and the volume of water in the basin should not more than 1 liter. The sediment was wet sieved by agitating and puddling in the basin of water until most or the entire fraction was passed. The sand fraction will remain on the surface of the sieve. The sieve and its content were transferred to dry in an oven at 80°C. After drying, the sediment was carefully weight to obtain dry weight of sand fraction. The weight of the silt-clay fraction (%) was obtained by difference.

$$\textbf{Silt content (\%)} = \frac{\textbf{(Total weight of sample – weight of sand) x 100}}{\textbf{Total weight of sample}}$$